Claims

1. An apparatus, comprising:
   a. an upper element;
   b. a lower element, wherein the upper element and the lower element are configured to be brought together to form a processing volume; and
   c. a seal energizer configured to maintain the upper element against the lower element to maintain the processing volume, the seal energizer configured to control a sealing pressure in a seal-energizing cavity that varies non-linearly with a processing pressure generated within the processing volume.

2. The apparatus of claim 1, wherein the seal energizer is configured to minimize a non-negative net force against one of the upper element and the lower element above a threshold value, the net force following the equation P1*A1 - P2*A2, wherein P1 equals the sealing pressure, P2 equals the processing pressure, A1 equals a cross-sectional area of the seal-energizing cavity, and A2 equals a cross-sectional area of the processing volume.

3. The apparatus of claim 2, wherein the seal energizer is configured to maintain a difference P1 - P2 substantially constant during a processing cycle.

4. The apparatus of claim 1, wherein the seal energizer comprises a first cavity and the seal-energizing cavity, the first cavity coupled to the seal-energizing cavity, the seal energizer configured so that a first pressure generated within the first cavity generates a second pressure in the seal-energizing cavity larger than the first pressure.

5. The apparatus of claim 2, wherein the cross-sectional area A1 is larger than the cross-sectional area A2.

6. The apparatus of claim 1, further comprising a means for generating supercritical conditions coupled to the processing volume.

7. The apparatus of claim 6, further comprising a CO_2 supply vessel coupled to the processing volume.

8. The apparatus of claim 1, wherein the upper element and the lower element form a supercritical processing chamber.

9. The apparatus of claim 1, wherein the seal energizer comprises a hydraulic piston coupled to the lower element and configured to maintain the processing volume.

10. An apparatus, comprising:
    a. an upper element;
    b. a lower element, wherein the upper element and the lower element are configured to be brought together to form a processing volume; and
    c. means for maintaining a seal between the upper element and the lower element to maintain the processing volume, the means for maintaining a seal configured to control a sealing pressure in a seal-energizing cavity that varies non-linearly with a processing pressure generated within the processing volume.

11. A method of maintaining a processing volume, the method comprising the steps of:
    a. generating a processing pressure within a processing volume; and
    b. controlling a sealing pressure to form and maintain a processing volume, wherein during a processing cycle the sealing pressure is varied non-linearly with the processing pressure.

12. The method of claim 11, wherein the sealing pressure is related to the processing pressure by the equation $\Delta F = P1*A1 - P2*A2$, wherein P1 equals the sealing pressure, P2 equals the processing pressure, A1 equals a cross-sectional area of a seal-energizing cavity, and A2 equals a cross-sectional area of a processing volume, and the sealing pressure is varied to maintain ΔF above a threshold value.

13. The method of claim 12, wherein a cross-sectional area of the processing volume is smaller than a cross-sectional area of the seal-energizing cavity.

14. The method of claim 11, wherein the step of generating a processing pressure comprises containing a high-pressure processing fluid in the processing volume.

15. The method of claim 14, wherein the high-pressure processing fluid comprises supercritical carbon dioxide.

16. The method of claim 12, wherein the step of controlling a sealing pressure comprises generating a hydraulic pressure in the seal-energizing cavity.